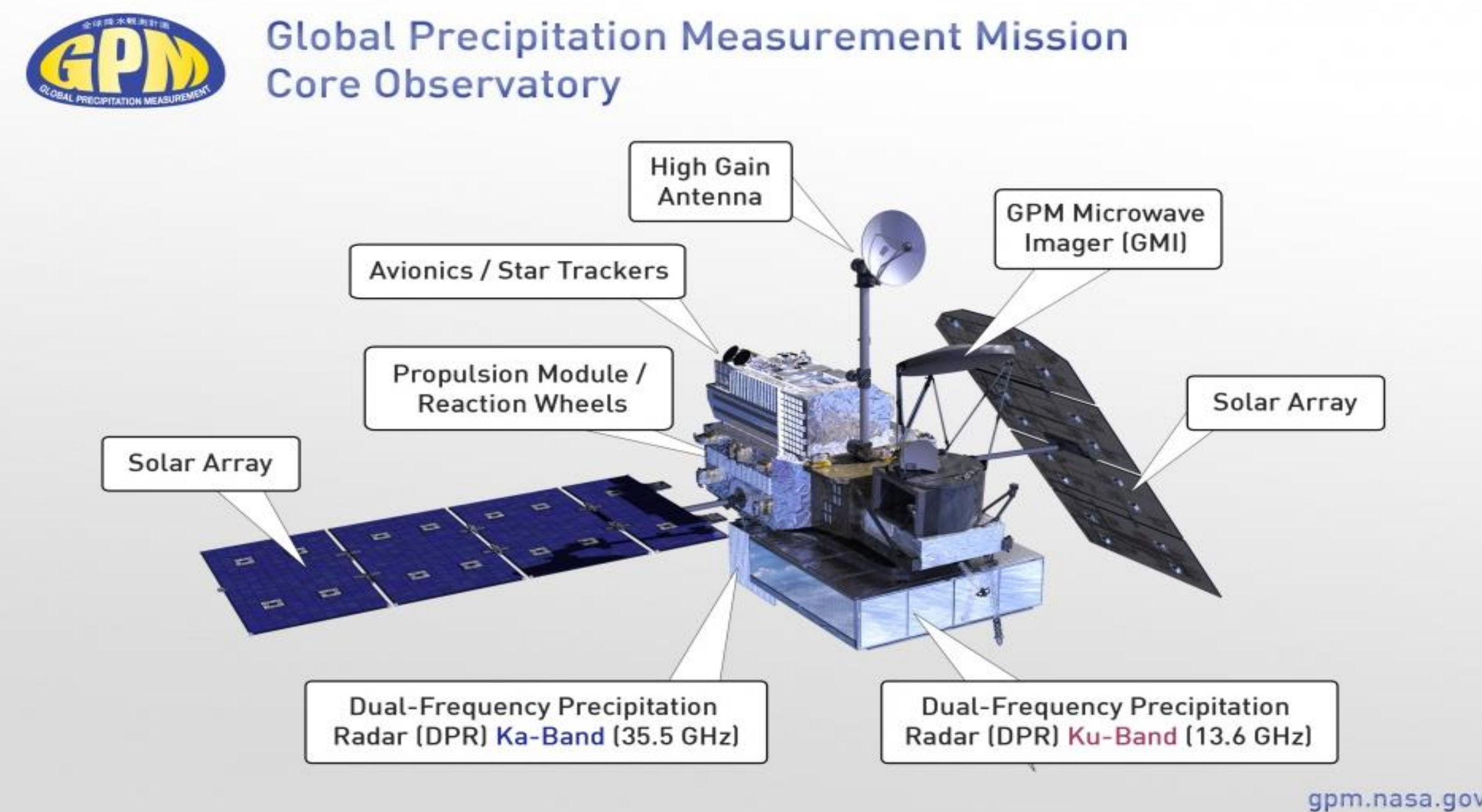


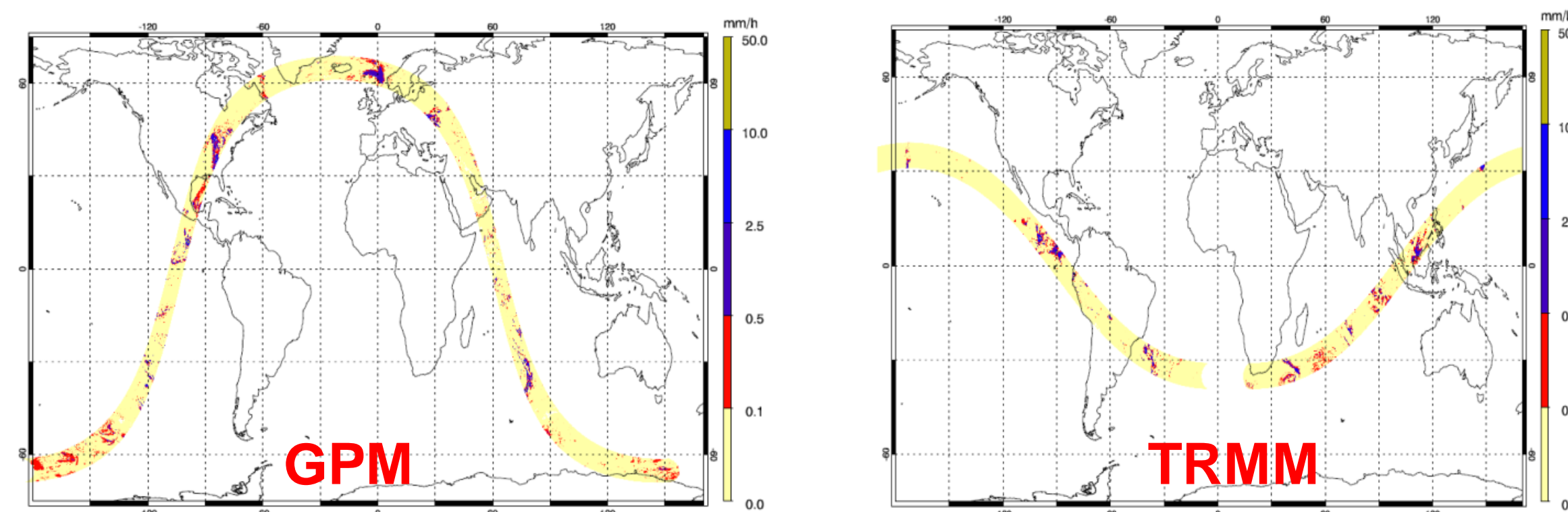
Global Precipitation Measurement (GPM)



http://www.nasa.gov/mission_pages/GPM/main/

GPM:

- Built upon Tropical Rainfall Measuring Mission (TRMM) legacy for next-generation global observation of rain and snow.
- Launched February 2014, Dual-frequency Precipitation Radar (DPR) and GPM Microwave Imager (GMI) data are available near real time.
- Broad global coverage ~70°S – 70°N.
- Ka (35.5 GHz)/Ku (13.6 GHz) band radar with 245/125-km swath, and 13-channel (10.65, 18.70, 23.80, 36.5, 89.0, 165.5, and 183.31 GHz) GMI with 850-km swath: Better retrievals for heavy, moderate, and light rain and snowfall.



GPM Near Realtime Data:

- Level 1 radiometer and radar products: Radiance, brightness temperature and radar powers.
- Level 2 retrieval products: Reflectivity and precipitation estimates from DPR, GMI and other partner sensors.
 - DPR, Ka, Ku reflectivity (~5-km resolution)
 - Goddard Profiling Algorithm (GPROF) rainrate (~9-km resolution)
 - Surface precipitation, convective precipitation fraction
 - Liquid precipitation fraction, probability of precipitation
 - Rain water path, cloud water path, ice water path, mixed water path
 - Total column water vapor
 - Combined precipitation products
- Level 3 time-averaged and space-averaged precipitation rate.

GMI Rainrate Data Assimilation

Project Goals:

- To develop methodology to implement GPM GMI GPROF surface precipitation data with GSI and WRF model
- To investigate the potential and the value of utilizing GPM observation into NWP for operational environment.

Model and Data Assimilation System:

WRF ARW V3.5.1

Nested domains:

Outer: 15-km covering CONUS

Inner: 5-km focusing on northeast US
Community GSI v3.3

Experiments:

Case study:

2014-05-15 heavy rainfall event

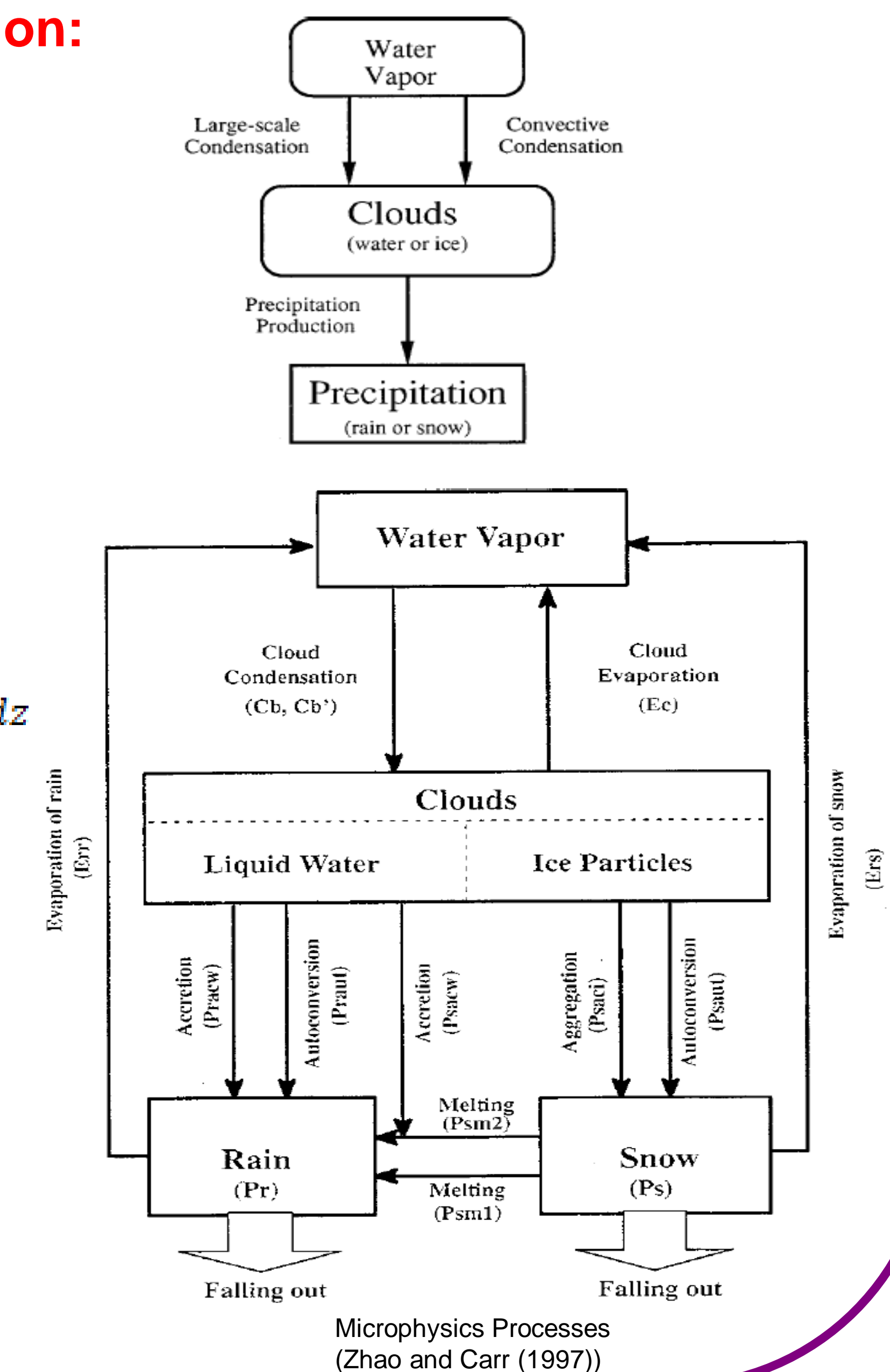
Data:

GMI 2AGPROF retrieved surface precipitation rate

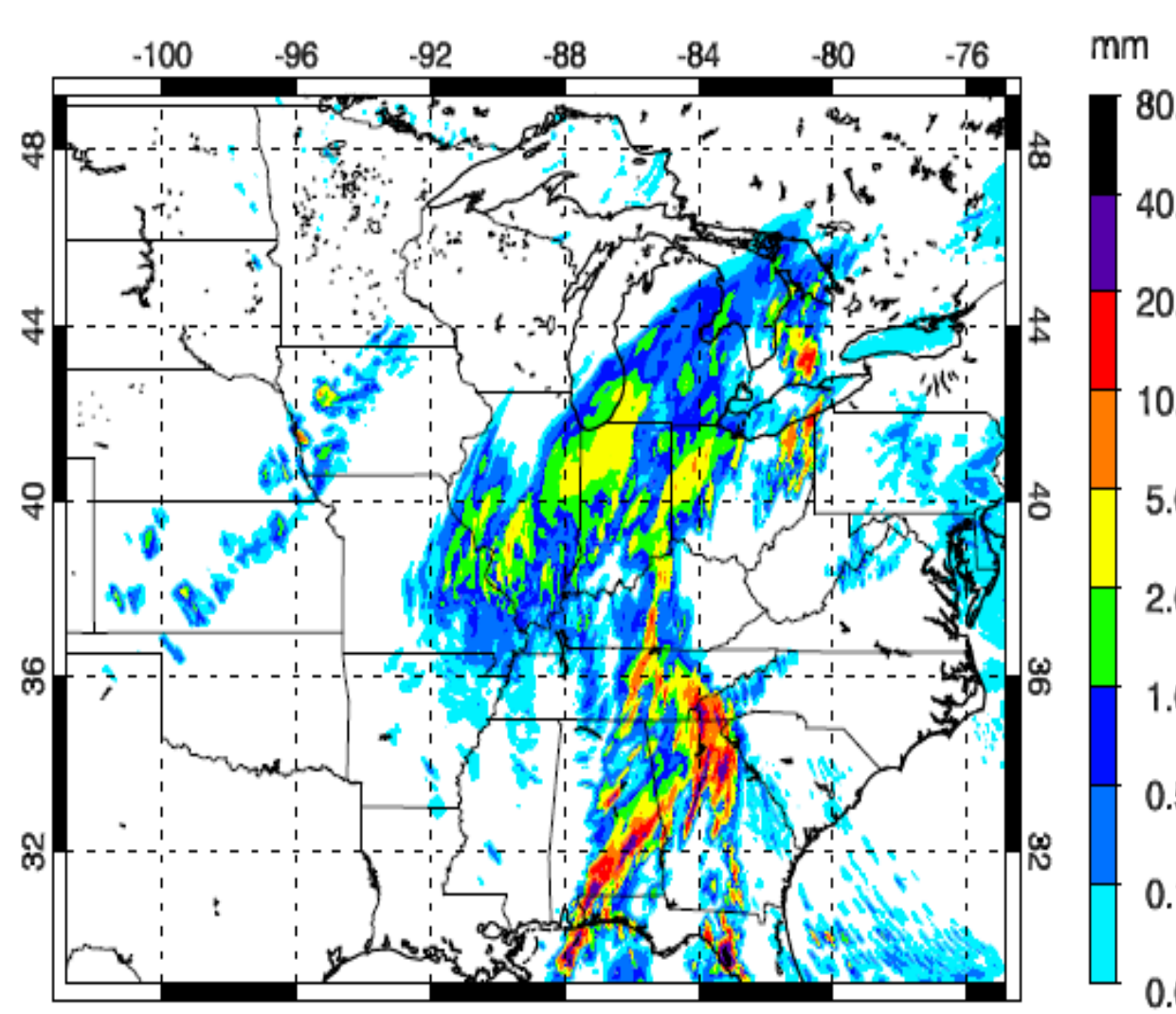
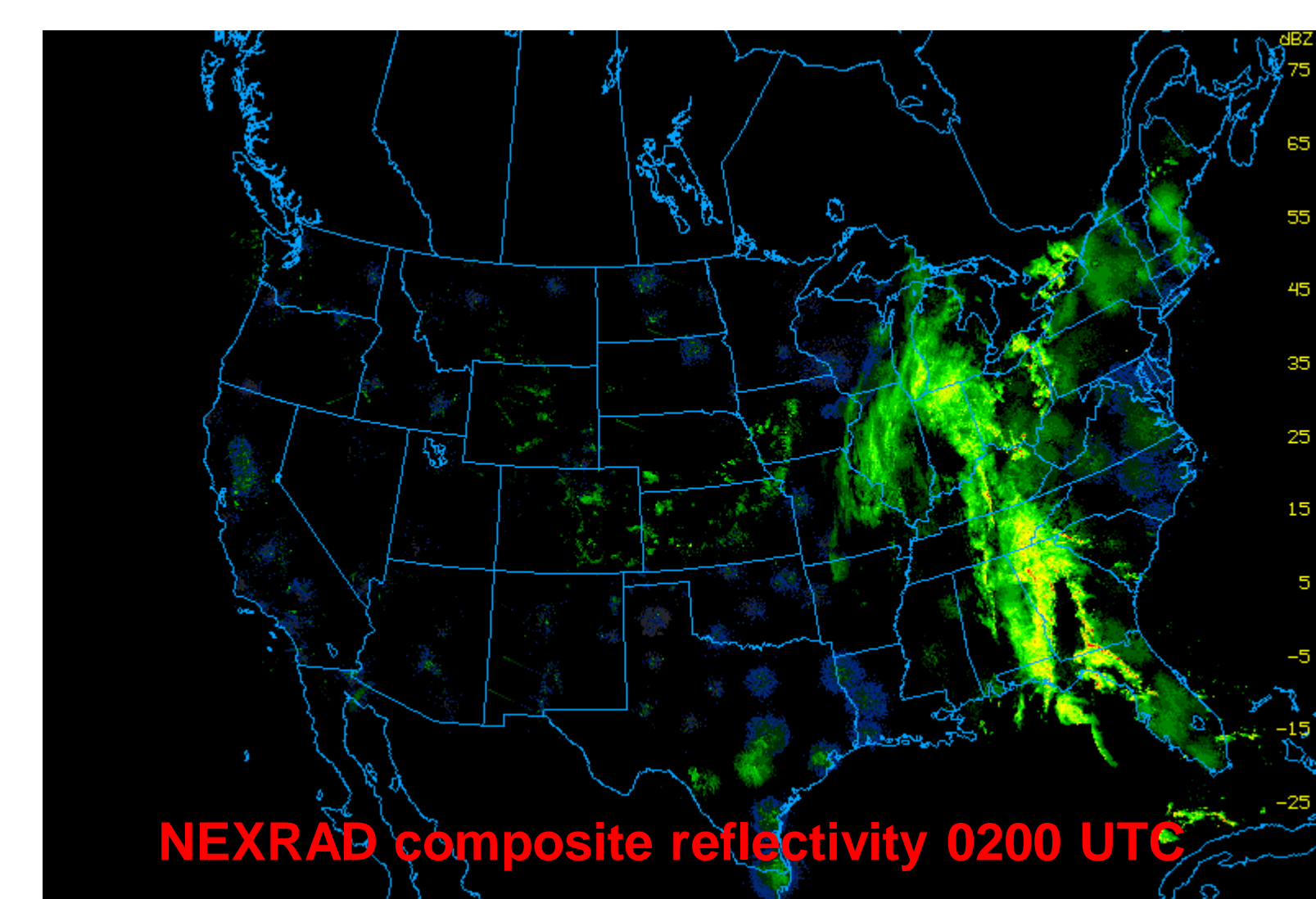
GSI Physics Forward Model for Rainrate Assimilation:

- Sources: Large scale condensation
Convective condensation
- Sinks: Precipitation production
Evaporation
- Convective Precipitation: Pan and Wu (1995)
 - Simplified Arakawa and Schubert scheme
 - Convection occurs when the cloud work function exceeds a threshold
- Grid-scale Condensation and Precipitation: Zhao and Carr (1997)
 - Quasi-equilibrium of cloud work function to determine mass flux
 - Hydrometeors: cloud water, rain, cloud ice, and snow
 - Microphysical processes: condensation, evaporation, accretion, autoconversion, melting/freezing, aggregation of ice crystals

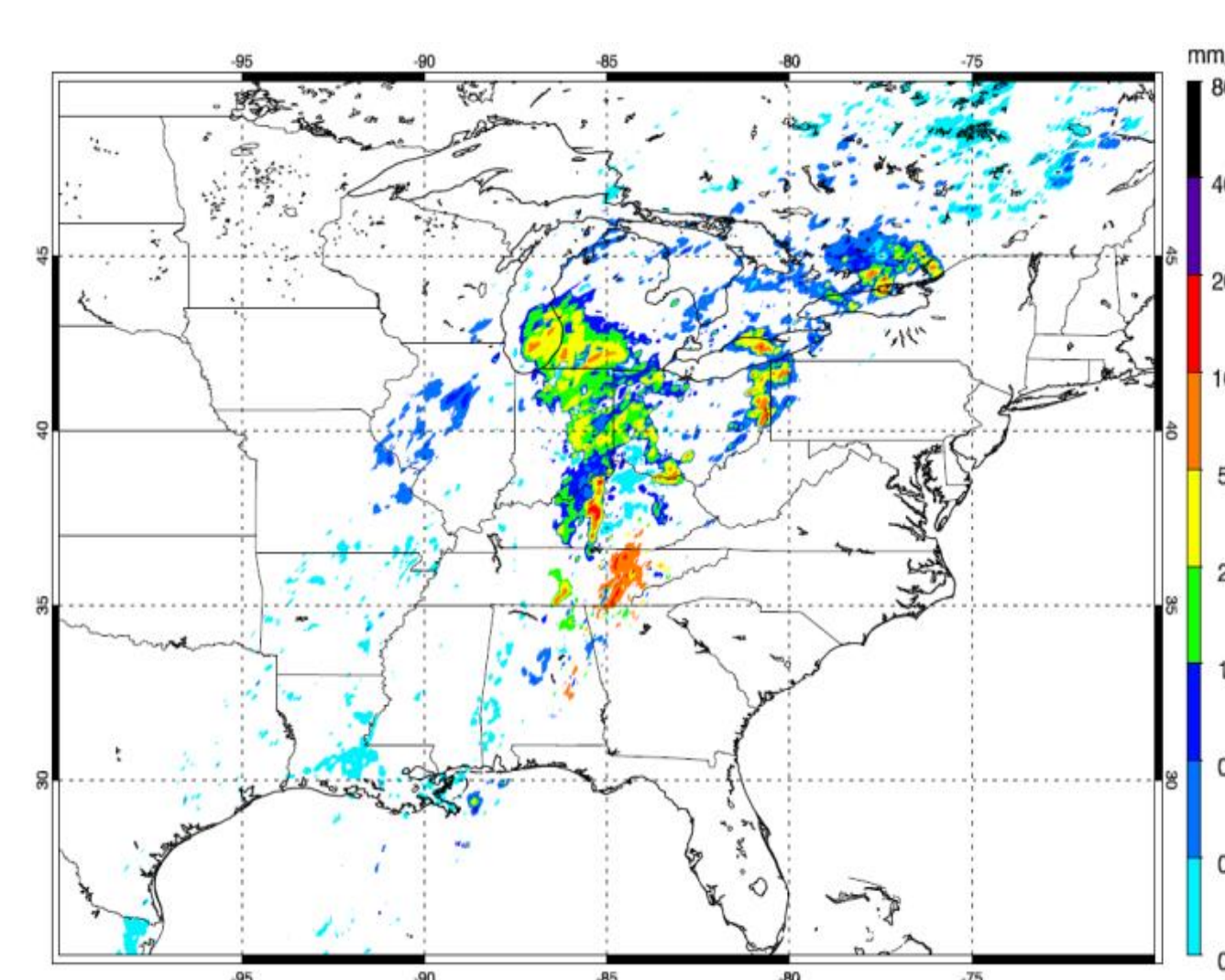
$$\text{Cloud work function: } A = \int_{z_0}^{z_T} \frac{g}{C_p T} \frac{\eta}{1 + \gamma} (S_{\text{cloud}} - S_{\text{env}}) dz$$



Preliminary Result



WRF 1-h rainrate forecast at 0200 UTC

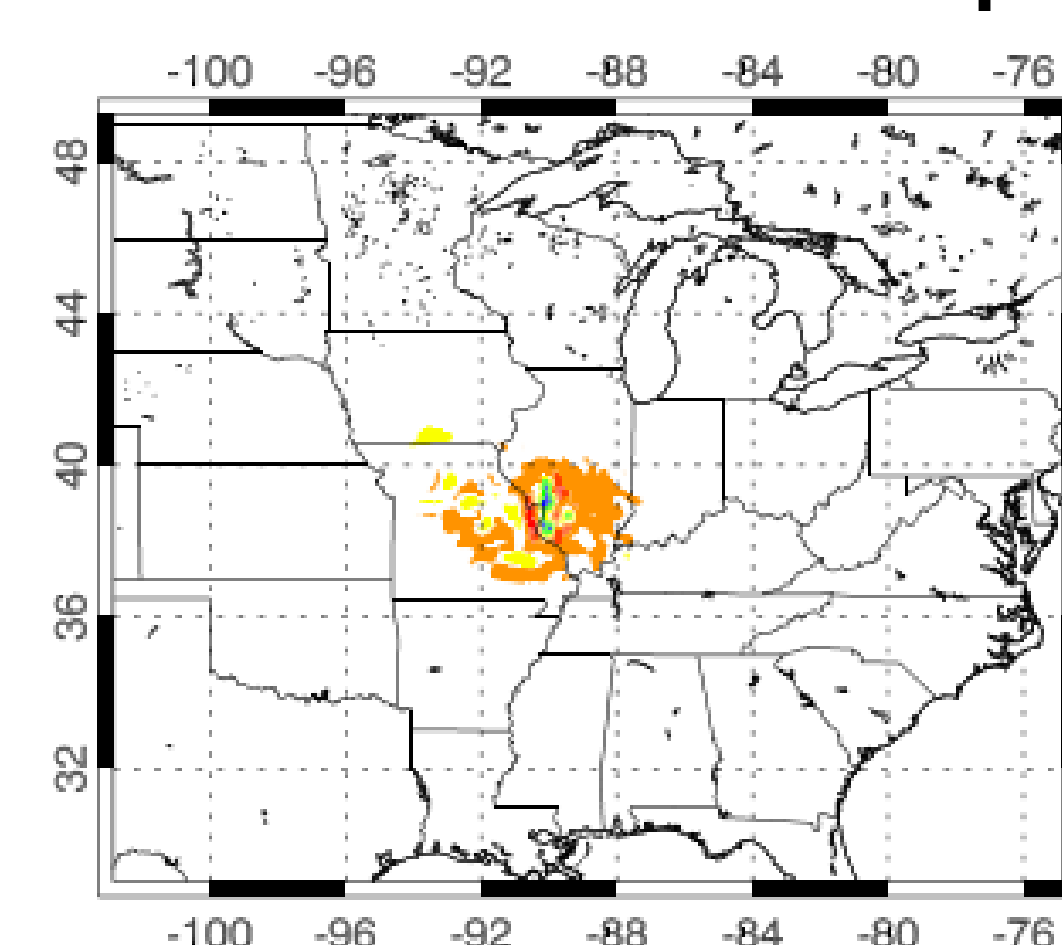


GMI rainrate at 0149 UTC

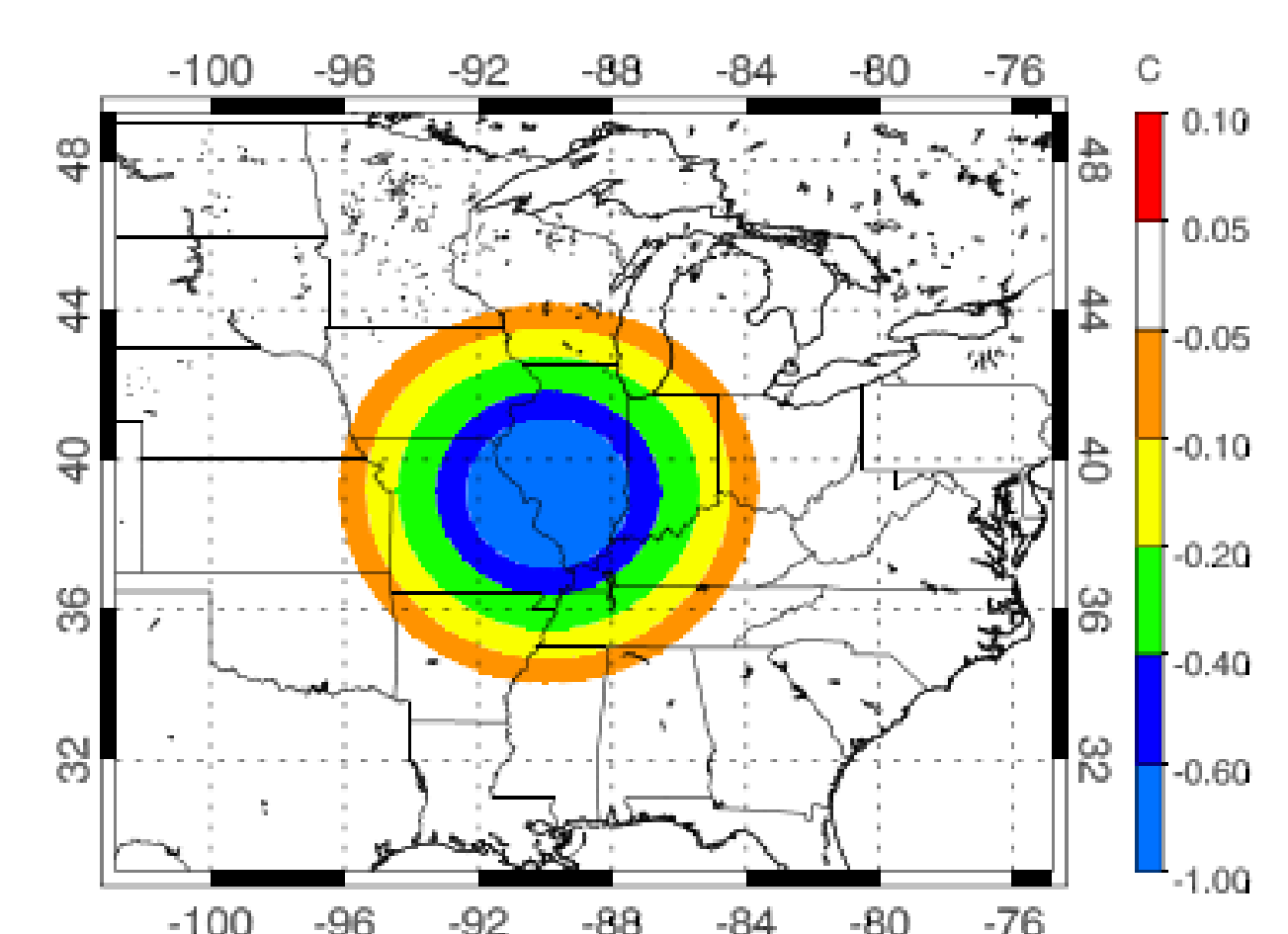
Single Data Test with grid scale precipitation processes

Observation: 12 mm/hr rainrate at (89.93°W, 39.02°N)

Increment on q



Increment on T



Discussion & Next Steps:

- Impact of GMI rainrate data on grid scale condensation and precipitation has been found on temperature and moisture fields with single data test experiment.
- Ongoing work: convective precipitation tangent linear and adjoint code of GSI.
- Check correctness of tangent linear and adjoint code of all precipitation modules.
- Convergence test for cost function and gradient.
- Case studies for the 2014-05-15 heavy rainfall event.
- Continuous assimilation tests and evaluation.

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